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ABSTRACT

This paper illustrates and explains the relationship between drawing ability and spatial and visual-perceptual ability; it defines those terms and explores their connection to intelligence and information processing as well as their potential implications for education and training. Discussion covers results of recent studies, which suggest that art behavior and spatial ability are normally distributed. In addition, the paper shows that drawing and spatial/visual-perceptual skills demand similar brain functions for information processing: drawing, as an output of visual perception, enables the conversion of an abstract visualization to a concrete product. This involves a cognitive operation, sometimes called information processing, which allows transference of one type of information to another. The suggested implication is that all students have drawing and spatial potential that may be developed through art education in general, and through drawing experiences in particular. Training in visual literacy, in drawing, and in communication through visual perception may enhance the effectiveness of the use of computers and multimedia, an ever-present and growing force in today's society. (Contains 49 references.) (AEF)

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Drawing as Visual-Perceptual and Spatial Ability Training

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Abstract

The purpose of this discussion is to illustrate and explain the relationship between drawing ability and spatial/visual perceptual ability and their potential implications for education and training. This work defines drawing, spatial, and visual-perceptual abilities, and their connection to information processing and intelligence. It also discusses results of recent studies which indicate art behavior and spatial ability are normally distributed. The suggested implication is that all students have drawing and spatial potential that may be developed through art education in general and drawing in particular.

Background

Drawing may be the most important variable in art performance and ability. "...[I]t is the easiest mode of visual arts expression to assign, administer, and measure; more importantly, it has been recognized as basic to expression in all art forms and as a correlate of many other attributes, including general intelligence...") Stalker as cited in Clark, 1989, p. 99). In fact, some believe the development of this skill is important to the total development of the child. As Robach states "...I have come to believe that drawing is the missing link to American success in educating every child" (1994, p. 3).

Given the above assertion, why doesn't the education system place more emphasis on the development of visual-perceptual skills? This is not a foreign concept. It has long been a consensus among art educators "...that developing or increasing visual readiness is one of the major goals of a good art program" (Herberholz & Alexander, 1985, p. 22). A brief look at the history of art education may shed some light on this dilemma.

The form and function of art education has changed over the years due to the change in the philosophical underpinnings. Art in the schools had various objectives from the practical needs of life (crafts oriented) and the development of hand-eye coordination and the acquisition of mechanical skills necessary for the industrial age (Eisner, 1972). In the latter half of the 20th century the concept of innate creativity came to the fore changing the focus of art education from specific skills training to that of enrichment of the total individual. As a result, the role of the art teacher changed from instructor to nurturer. Instead of the rigid training of specific skills, the teacher became a provider of materials who encouraged self-expression.. The art teacher's function became that of observer and facilitator thus reflecting one of today's popular philosophies in art education (Gardner, 1990).

This approach to education in the visual arts has had a notable impact on the perception of the learner both from the teachers' and students' perspectives. Students who had more developed visual perceptual skills succeeded in meeting or exceeding expected standards for art production. This led to the belief that only some individuals were "talented" or had "special gifts". Accordingly, some educators, students, and the general public have come to believe that art skills are a behavioral peculiarity attributed to only a few (Clark & Wilson, 1991).

Recent studies, however, suggest art behavior is normally distributed (Clark, 1993; Edwards, 1979; Gardner, 1982; Gardner, 1993). Others also believe there is a link between art and spatial ability (Eliot & Smith, 1983). Visual perception is needed for the development of drawing and spatial skills as the sensory input for both is primarily visual. If visual-perception can be taught and learned through drawing training, then the concept of artistic "giftedness" may be redefined as a skill *potential* that may be developed beyond an expected norm resulting from life experience alone. Consequently, if spatial ability is related to, and possibly improved by drawing, i.e., visual-perceptual training, perhaps it is feasible to train perception through drawing.

Drawing Ability

Drawing exhibits principles of design some of which can be evaluated by a test instrument called the Clark's Drawing Abilities Test (CDAT) (Clark, 1987). These drawings may be either representational or stylized (see Figure 1) without effecting the scoring rubric. Each task on the CDAT is rated on a scale of one to five.

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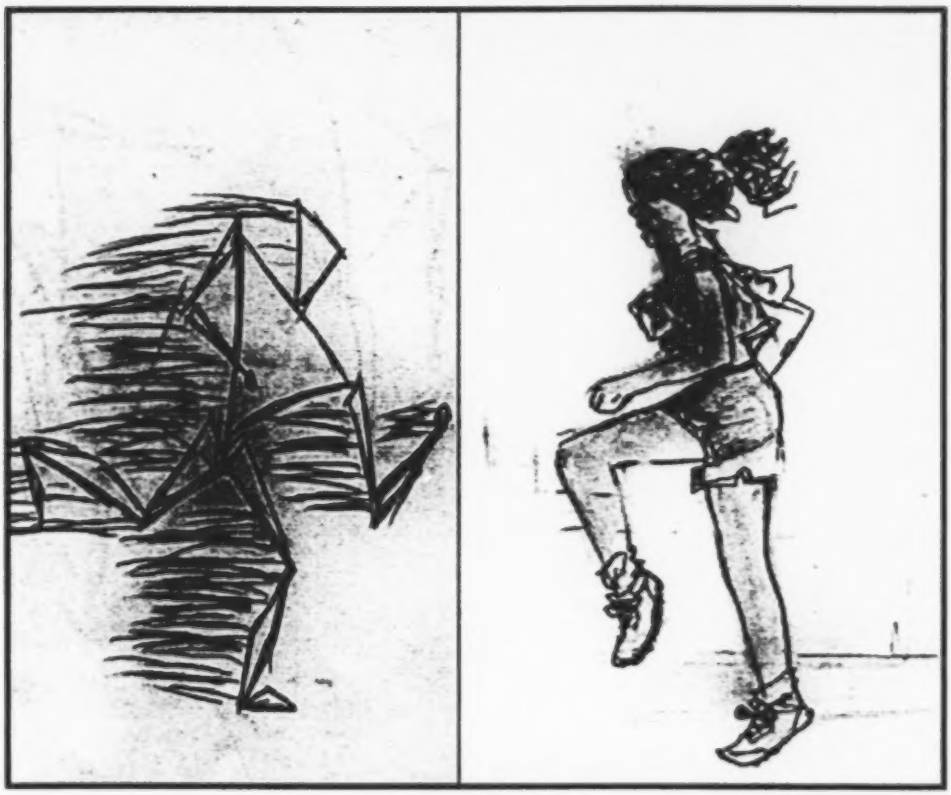

Figure 1. Realistic (right) and stylized (left) interpretations of a runner as drawn by two eighth graders. CDAT drawing task number 2. Both scored 5.

Both representational and stylized drawings may score 5. Concepts examined in each of the tasks are listed below:

Task 1	Task 2	Task 3	Task 4
perspective	action	receding space	imagination
texture	body proportion	grouping	
size	recognition of detail		
recognition of detail			

Spatial Ability/Visual-Perceptual Ability

Spatial ability has been variously defined over the years with researchers debating over the exact function and number of contributing factors (Cohen, 1982; Dixon, 1983; Egan, 1979; Eliot & Smith, 1983; Gardner, 1993; Horn & Smith, 1945; McGee, 1979; Smith, 1964; Pellegrino & Kail, 1982; Pellegrino & Hunt, 1991; Youngblood, 1979). John Eliot (1983) combined various definitions into a general statement that spatial factors reflect "... the perception and retention of visual forms and the mental manipulation and reconstruction of visual shapes" (p. 9). Linn & Peterson (1985) defined spatial ability as representing, transforming, generating, and recalling non-linguistic information. All of these mental operations are necessary to drawing and shall be discussed in a subsequent section.

Although many factors of spatial ability have been identified, researchers most often recognize three: spatial relations, spatial orientation, and spatial visualization (Rowe, 1991). These definitions coincidentally correspond almost verbatim to those used in the Test of Visual-Perceptual Skills (non-motor) (TVPS) which is used solely to

evaluate mental capabilities related to spatial ability. TVPS terminology is also in agreement with other researchers' definitions of the spatial ability factors (Cohen, 1982; Dixon, 1983; Eliot & Smith, 1983; Lacey & Guilford as cited in Eliot & Smith, 1983; Lohman as cited in Pellegrino & Kail, 1991; J. W. French as cited in Eliot & Smith, 1983; Rowe, 1991). By definition, spatial and visual-perceptual abilities are synonymous. Gardner's definitions used in the TVPS are as follows:

Visual discrimination [Spatial relations]. "A child's ability to remember for immediate recall (after four or five seconds) all of the characteristics of a given form, and being able to find this form from an array of similar forms."

Visual-spatial relationships [Spatial orientation]. "A child's ability to determine, from among five forms of identical configuration, the one single form or part of a single form that is going in a different direction from the other forms."

Visual form constancy [Spatial visualization]. "A child's ability to see a form, and being able to find that form, even though the form may be smaller, larger, rotated, reversed, and/or hidden" (Gardner, 1988, p. 65).

Drawing and Spatial Abilities

The CDAT focuses on a number of standard elements of art as criteria in its analysis of drawing performance. By comparing these against the definitions for spatial/visual criteria, a theoretical common ground may be identified.

Spatial/Visual Criteria	Drawing Criteria	
• Relations—recall and find characteristics of a given form	• perspective • proportion	• texture • size
• Orientation—identify form or part going in a different direction	• shape • action	• detail
• Visualization—identify a form changed in size, position, direction or hidden	• receding space • imagination	• grouping

Paul Messaris cited Howard Gardner's (1983) question: "...because spatial intelligence contributes to picture-making ability, might spatial intelligence be an area of cognitive functioning enhanced by experience with images?" (Messaris, 1994, p. 27). In fact, several specific subject areas have been identified as correlating with these abilities. Eliot & Smith pointed out several positive correlations between spatial ability and a general art class (.404) and specific art-related skills such as technical drawing (.45), metal work (.485), mechanical science (.492), and woodworking (.67) (Eliot & Smith, 1983, p. 436 & 442).

Relationships to Intelligence

Educational achievement and artistic performance—including drawing—require proficient spatial abilities. The importance of spatial ability in learning, communication, and life skills has become increasingly evident. Spatial ability positively correlates with success in areas such as mathematics, physics, technical drawing and woodwork (Eliot & Smith, 1983). Taking this a step further, Smith asserted that "...spatial ability has a wider significance than as mere aptitude for courses in art and technical subjects" (Smith, 1964, p. 100). Many other areas—engineering and interior decorating to name a few—require analytical visual skills and already have a proven relationship with spatial abilities (Eliot & Smith, 1983). A relationship between spatial ability and certain types of intellectual adeptness has also been well established (Biederman, 1948; Caldwell & Moore, 1991; Cohen, 1982; Egan, 1979; Eisner, 1972; Gibson, 1953; Gardner, 1982; Gardner, 1993; Goins, 1958; Goodenough, 1926; Kolers, 1979: Laurendeau & Pinard, 1979; Loyacono, 1993; Messaris, 1994; Olson & Bialystok, 1983; Pellegrino & Kail, 1982; Pellegrino & Hunt, 1991; Salomon & Perkins, 1987; Sherman, 1947; Smith, 1964; Szeto, 1975; West & Morris, 1985). Academic, career, schooling, and visual decisions along with visual and verbal communication are just some of the everyday skills which require space, distance, and directional capabilities all of which depend on or are related to spatial abilities.

Evidence suggests a relationship between inherent art ability and general intelligence (Clark, 1989; Clark, 1993; Clark & Wilson, 1991; Clark, Zimmerman & Zurmuehlen, 1987; Cook, 1985; Cunningham & Reagan,

1972; Eisner, 1972; Gardner, 1982; McFee, 1970; Messaris, 1994; Shannon, 1991; Tiebout & Meier, 1936). Messaris supported the concept of this relationship when he stated, "It is conceivable that the enhancement of depth-perception abilities [spatial] might lead to a more general stimulation of one's capacity for perceiving and thinking about three-dimensional space, and in that case we would be dealing with a type of cognitive activity that plays a very important role in general intelligence" (Messaris, 1994, p. 12).

"Proponents of visual education often argue that experience with visual media is not just a route to better visual comprehension but also may lead to general enhancement of cognitive abilities" (Messaris, 1994, p. 3). Drawing, through its exercise of cognitive functions common to many modes of expression, may be one way to effectively train spatial/perceptual abilities, promote visual literacy, and enhance intellectual performance.

This perspective gives rise to questions concerning the relationships between drawing ability, spatial ability, and intelligence and/or cognitive skills (see Figure 2).

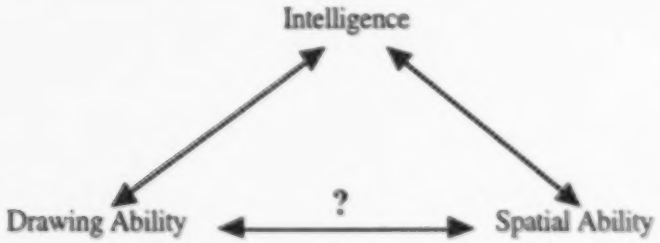

Figure 2. Conceptual map of interrelationships and suggesting the questionable link between drawing ability and spatial ability.

Some studies show that students with greater spatial/perceptual skills are more skilled in visual interpretation of their reality (drawing ?) and achieve greater success in areas such as math, science, and others requiring visual perceptual skills. Spatial test results reported by Eliot & Smith (1983) suggest there is a significant relationship between scores in these academic areas and spatial ability. The relationship between spatial ability and certain academic and skill areas leads to the question of how to delineate and train spatial ability for the purpose of developing cognitive skills. "There is clearly a very great need to devise methods for identifying those different types of ability which are necessary for success in subjects such as mathematics and science" (Smith, 1964, p. 23). Assuming there is a relationship between drawing and spatial competencies, drawing may be one of these abilities that are necessary to academic success in general and visual-perceptual dependent areas specifically.

Normal Distribution

The debate over whether or not the ability to draw and spatial ability are gifts of nature or products of nurture continues (Eliot & Smith, 1983; Gardner, 1982; Gardner, 1990; Lewis, 1973; McFee, 1970; McGee, 1979; Olson & Bialystok, 1983; Smith, 1964). Perhaps finding a common ground will help clarify at least some of the surrounding issues. One of these areas of commonality is trainability. Both drawing and spatial skills can be trained. There is evidence to support the trainability of spatial competence (Cunningham & Reagan, 1972; Sherman, 1947; Szeto, 1975). In 1919 Manuel made the same suggestion regarding artistic ability when he questioned, "Interest [in art-related endeavors] may indicate either a superior innate ability or merely a rather high development of a rather ordinary endowment..." (as cited in Clark, Zimmerman, & Zurmeuhlen, 1987, p. 15). These two observations seem to suggest common potentials developed through uncommon effort.

Since drawing and spatial/perceptual skills can be trained, this suggests both are normally distributed potentials such as reading and math, and therefore, can benefit from instruction (Edwards, 1979). Nature then plays a limited role by supplying a core of *potential* aptitudes, while a nurturing environment may stimulate and develop them. Since it has already been established that visual-perceptual skills can be trained and that they are synonymous with spatial skills by definition, it follows that each would benefit from the same training. Learning to draw may be one of these common areas. Referring back to their respective connections to intelligence, one might deduce that nurturing visual-perceptual skills through drawing training would enrich all three areas (see Figure 2).

Information Processing/Training

Visual perception is learned (McFee, 1970). Drawing and spatial or visual-perceptual skills have similar brain functions for the processing of information. Drawing, as an output of visual perception, enables the conversion of an abstract visualization to a concrete product. It involves a cognitive operation, sometimes called information processing, which allows transference of one type of information to another (Biederman, 1948; Gardner, 1982; Pellegrino & Hunt, 1991; Sherman, 1947). Thus, an abstract mental picture (a visual perception) can be translated into a concrete drawing. The more developed the spatial/perceptual skills, the more sophisticated the attending representation.

These mental operations also benefit from similar training methods, i.e. tactile and kinaesthetic. Visual and tactile sensual stimulations are the primary sensory inputs needed for drawing and one mode of training spatial ability (Meumann as cited in Clark, 1989, p. 99). "The development of perceptual skills is an often stated goal of art education. Both art educators and psychologists have referred to the relationship between perception and child art" (Grossman, 1970, p. 51). This relationship between perception and art manifests itself more specifically in the ability to draw. "Visual perception, as the term is used here, is the process by which phenomena are apprehended by the mind through the medium of the eye" (Goins, 1958, p. 1). As a necessary skill in mental development As evidenced by the known link between general intelligence and drawing ability, perceptual skill development is also recognized as a necessary skill in mental development (Clark, 1989; Clark, 1993; Clark & Wilson, 1991; Clark, Zimmerman & Zurmuehlen, 1987; Cook, 1985; Cunningham & Reagan, 1972; Eisner, 1972; Gardner, 1982; McFee, 1970; Messaris, 1994; Shannon, 1991; Tiebout & Meier, 1936). It appears spatial development parallels artistic development and is dependent on tactile and kinaesthetic motor activity.

> For it is not until after 7-8 years of age that measurement, conceptual co-ordination of perspective, understanding of proportions, etc., result in the construction of a conceptual space marking a real advance on perceptual space. All the same, it is worth noting that despite their differences and the time lag which separates them, both perceptual and representation construction are to some extent repetitive and possess a factor in common. This common factor is motor activity. (Piaget & Inhelder, 1967, p. 13).

Sherman (1947) rigidly applied motor training techniques using drawing for training of visual perception. He noted that the increase in visual perceptual skills after drawing training resulted in improved visual acuity, for example, clarity of central vision and the ability to identify a shape of a certain size at a certain distance. The symbiotic nature of these functions was further extolled when Cunningham & Reagan (1972) pointed out that cognitive abilities and emotional development were also enhanced by such training.

Implications

Clarification of the interrelatedness of the above elements and the fact that they are independently related to general intelligence has important implications for art education and curriculum development. As an instructional strategy and training, drawing may potentially be used to promote cognitive skills as well as those related more directly to visual perception. The connection to visual literacy, the ability to read and write visually, is central to this discussion. Drawing is a form of visual communication and, as such, an implement of visual literacy which allows one to communicate effectively graphically. Visual perceptual and spatial skills enable visual communication resulting in visual literacy. By acknowledging the relationship between drawing and spatial ability, we may more accurately design art education curricula to teach visual literacy and meet these learning needs of children. Instructional design concerns relative to these outcomes should not only apply the appropriate strategies and materials for development of these skills, but also take into consideration the sequential ordering, presenting, and training of spatial and visual-perceptual skills for the development of cognition and for more efficient information processing in general.

Despite the fact that there will always be individual differences, knowledge of visual-perceptual and drawing processes can have important implications on instructional design for technology application and integration. Computers and multimedia in particular are an ever-present and growing force in today's society. They are visual media requiring skills in visual communication as well as those of verbal language. Training in visual literacy/communication through visual-perceptual and drawing training may enhance the effectiveness of the use of this medium whether it be as developer or user. Computers are the key piece of hardware in instructional technology, and a powerful influence in today's education. Students and educators must be able to use both verbal and visual languages effectively. "Recently, educators have begun to realize that, first, this visual age requires visual as well as verbal skill of everyone, and second, the verbal and visual skills are interconnected and both must be developed" (Fransecky & Debes, 1972, p. 9). Drawing training, because of its relationship with visual literacy and

other cognitive areas, is essential to the total educational development of the child and has particular significance with respect to the ever-advancing communication technologies.

Summary & Conclusion

Drawing and spatial abilities share common conceptual ground, training and outcomes:

- Drawing and spatial abilities share common conceptual ground. Both have been associated with similar cognitive functions. They are related in mental function through a relationship in which drawing is dependent on spatial ability and spatial ability may be enhanced through drawing.
- Drawing and spatial abilities share common training. Both mature through tactile and kinaesthetic experience. Drawing is learned through repeated practice of a tactile and kinaesthetic nature. Spatial ability can be developed by physical manipulation and movement.
- Drawing and spatial abilities share common outcomes. Skills in each area directly relate to success in similar academic and professional fields which require visual-perceptual accuracy.

Art is not a frill, not does it train only fine motor skill. It also helps develop higher order thinking skills (Feldhous, 1992). Drawing is a means of planning and assembling ideas (Caldwell, & Moore, 1991). Another perspective looks at drawing as communication which represents unity in our minds (VanSommers, 1984). All expound the benefits of drawing.

Art is not an end, but a means to express, think, explore, satisfy, and solve. It is an entire group of media which, when appropriately applied, lead to learning, expression, visual literacy, and satisfaction. The language of drawing, as a single art form, crosses media boundaries and enables visual communication as well as heightening cognitive capabilities. By nurturing visual-perceptual skills through drawing training, spatial abilities may be enriched thus enabling transference of intellectual skills. I. Macfarlane Smith (1964) feels "...spatial ability has a wider significance than as a mere aptitude for courses in art and technical subjects". He goes on to quote Myers' 1958 study:

> In our judgment, spatial ability is an important and pervasive trait, affecting our perception of our environment and our style of thinking about it. When better tests are built and a better theory provided for their use, we believe it possible that we will find spatial ability to be similar in importance to such traits as verbal or social intelligence. (as cited in Smith, 1964, p. 100)

Educators in general and art educators specifically, may consider these concepts when analyzing their instructional goals. Subsequent research of an experimental nature may verify the connection between drawing and perceptual skills and intelligence with the possibility of predictability and the goal of educational reform. More research is needed on the training of spatial ability and its transferability to academic tasks.

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